

***Appendix F***  
***Distance Calculations for Aesthetic Analysis***

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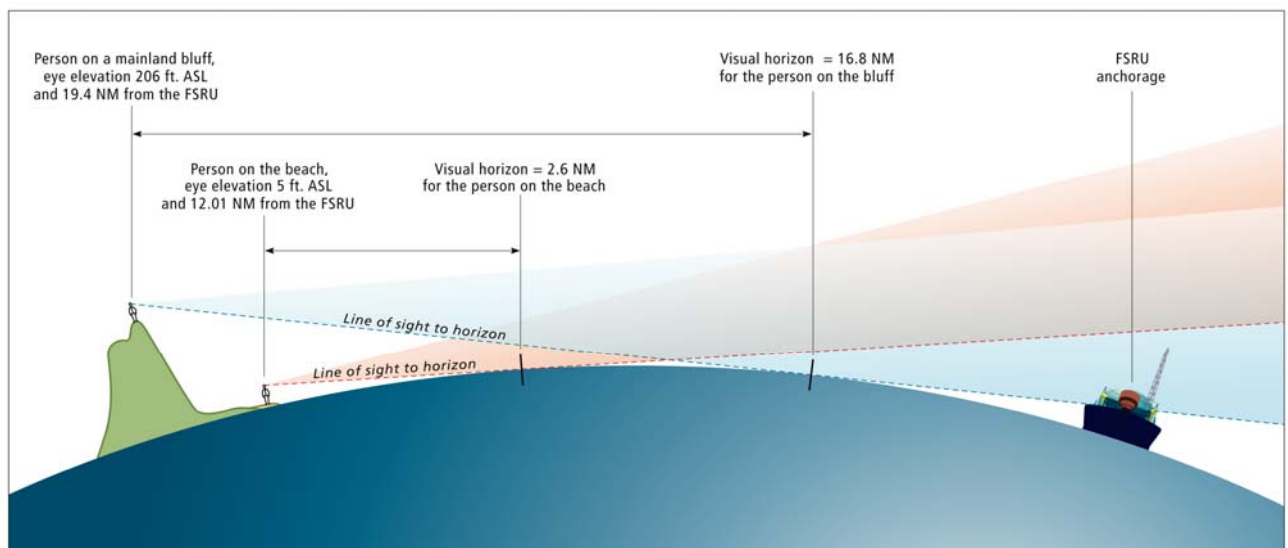


## Appendix F – Distance Calculations for Aesthetics Analysis

### 1. Introduction

This appendix discusses the methodology for the visual analysis, which is summarized in Section 4.4, “Aesthetics.” The visual simulations for the proposed FSRU were prepared to aid in the assessment of potential visual impacts of the Project, and specifically to determine whether or not all or some portion of the FSRU might be visible from various onshore and offshore locations. Simulations were conducted by Vallier Design Associates of Richmond, California, a firm that has performed numerous project simulations in California. Staff employed a variety of software applications for 3D modeling, CAD, photo editing, and GIS to generate the 3D models of the FSRU set in a spatial model based on real-world data, including land and bathymetric contours, GIS mapping, digital raster graphics, all combined with color photography. As a cross check, views of the FSRU were calculated using an equation to determine the visibility of the FSRU from various points on land (see Table F-1).

Under ideal conditions, factors that determine whether a viewer can see a distant object are the height of the viewer’s eye, the height of the object, curvature of the earth, and the distance of the viewer from the object, among others. As illustrated in the figure below, a viewer at sea level has a much shorter line of sight than a viewer standing on a bluff adjacent to the shore. Because the California coastline is not a straight line and elevations can range from sea level to more than 3,000 feet (914 meters [m]), the distance to the visual horizon when looking out at the ocean from any given point also varies greatly.



**NOT TO SCALE:** All distances, elevations, relative sizes and positions have been significantly exaggerated in an attempt to simplify a complex subject.

Due to the curvature of the earth's surface, the formula to calculate the distance of an observer's view to the horizon when looking out over a large body of water such as the ocean is calculated as follows:

$$(1.17) \times (\text{square root of eye height (in feet) above the water}) = \text{distance to the horizon in nautical miles (NM)}$$

Table F-1 shows the results of applying the distance visibility equation to determine the visibility of the FSRU from various points on shore. As shown, the FSRU would not be visible from points such as the southernmost tip of eastern Anacapa Island or Mandalay Shores but could be visible from locations that are closer and/or higher. However, the visibility calculations are not definitive because of the many factors that affect visibility. Therefore simulation modeling is used to approximate the appearance of the FSRU.

In reality, any calculations to determine distance to the horizon or how much of the FSRU would be visible from a given location are only approximations; atmospheric conditions such as variations in temperature, humidity, and atmospheric pressure affect visibility and can reduce a person's apparent visual horizon significantly. Air pollution can also reduce visibility. On the other hand, the effect known as looming (mirages), i.e., when an object "below" the horizon is visible, may occur. Looming causes distant objects to appear larger (and therefore closer) than normal near the horizon over a body of water, particularly when the sun is low in the sky.

## **2. Project Related Views**

### **2.1 Project Related Views From Onshore**

To evaluate the visual impacts of the FSRU, visual simulation modeling was conducted from two visually sensitive mainland locations: Leo Carrillo State Beach in eastern Ventura County, and Malibu Bluffs, 12 miles (19 kilometers [km]) east of Point Dume in Malibu. Leo Carrillo State Beach is the closest point of the mainland to the proposed FSRU anchorage (12.01 NM [13.83 miles or 22.25 km]) and is closer to the FSRU than any of the Channel Islands (the closest of which is Eastern Anacapa Island at 18.7 NM [21.5 miles or 34.7 km] from the FSRU). Visual analysis was calculated for a person standing near a road about 45 feet (13.7 m) above the beach. The second viewpoint where analysis was conducted is Malibu Bluffs at an elevation of 206 feet (63 m).

#### ***2.1.1 Visual Analysis at Leo Carrillo State Beach***

Using the formula provided above, if a person stood at the water's edge at Leo Carrillo State Beach and their eyes were 5 feet (1.5 m) above the ground surface, the visual horizon would be at about 2.6 NM (3 miles or 4.8 km), and the water surface at the FSRU mooring location (12.01 NM [13.83 miles or 22.25 km])

**Table F-1. Visibility of FSRU from Various Points on Land**

<b>Vantage Point</b>	<b>Eye Height Above Sea Level (feet)</b>	<b>Unobstructed View Distance, or Horizon (NM)<sup>1</sup></b>	<b>Distance to FSRU from Vantage Point (NM)</b>	<b>Height of FSRU Visible above Horizon (feet)<sup>2</sup></b>
Southeastern tip of eastern Anacapa Island	5	2.6	18.7	None (FSRU completely below horizon)
On beach at Ormond Beach Generating Station	5	2.6	16.0	33 (20% of FSRU)
Water's edge at Leo Carrillo State Beach	5	2.6	12.01	100 (61% of FSRU)
Mandalay Shores (at Wooley and Mandalay Beach Roads)	15	4.5	22.4	None (FSRU completely below horizon)
Oceanview Drive, Port Hueneme	15	4.5	18.7	17 (10.4% of FSRU)
SR 1 near Leo Carrillo State Beach	44.6	7.8	12.2	150 (91.5% of FSRU)
Malibu Bluffs	206	16.8	19.4	159 (97% of FSRU)
Encinal Canyon Road, Malibu	400	23.4	13.1	164 (100% of FSRU)
Anacapa Island, highest point	930	35.7	18.7	164 (100% of FSRU)
Top of Mugu Peak	1,271	41.7	14.1	164 (100% of FSRU)
Top of Saddle Rock	2,160	54.5	17.4	164 (100% of FSRU)
Santa Cruz Island, highest point	2,300	56.1	26.0	164 (100% of FSRU)

<sup>1</sup> Based on formula:  $(1.17) (\text{square root of eye height in feet}) = (\text{distance in nautical miles})$ .

<sup>2</sup> Total height of FSRU is 164 feet above sea level [Note: 4- to 8-inch diameter cold stack would not be visible from any point on shore]

away) would not be visible as it would be beyond the viewer's horizon, although the viewer could likely see some portion of the FSRU.

Standing on Leo Carrillo State Beach, which is elevated above sea level, they would be able to see some portion of the FSRU above the horizon.

$$(1.17) X \text{ (square root of eye height (in feet) above the water)} = \text{distance to the horizon in nautical miles (NM)}$$

In this case, where the eye height is “X,”

$$(1.17) (\text{square root of } X \text{ feet}) = 12.01 \text{ NM}$$

$$\text{Square root of } X \text{ feet} = 12.01 \text{ NM} \div 1.17$$

$$X \text{ feet} = (12.01 \text{ NM} \div 1.17)^2$$

$$X \text{ feet} = (10.26)^2$$

$$X \text{ feet} = 105$$

From sea level (0 feet above sea level) at the water’s edge at Leo Carrillo State Beach, the viewer would be able to see above a point on the FSRU 105 feet (32 m) above the water, or the top 59 feet (18 m) of the FSRU.

Because it is more likely that a person would be standing at the water’s edge, their eyes would be approximately 5 feet (1.5 m) above sea level. Therefore, the visual horizon of that person (i.e., 2.6 NM) has to be subtracted from the overall distance between the FSRU and the vantage point, i.e.,  $12 - 2.6 = 9.4$  NM. Therefore, using the formula above:

$$(1.17) (\text{square root of } X) = 9.4$$

$$\text{Square root of } X = 9.4 \div 1.17$$

$$X = (9.4 \div 1.17)^2$$

$$X = (8.0)^2$$

$$X = 64 \text{ feet}$$

The results of the equation indicate that a person standing on the water’s edge could be able to see above a point on the FSRU 64 feet above the water surface; in other words the top 100 feet of the FSRU ( $164 - 64 = 100$ ).

### *2.1.2 Visual Analysis at Malibu Bluffs*

The elevation of Malibu Bluffs is approximately 201 feet above sea level. If a person stood at the top of the bluffs his or her eyes would be approximately 206 feet (62.8 m) above the ground surface, and his or her unobstructed visual horizon would be about 16.8 NM (19.3 miles or 31.1 km). From this vantage point most of the FSRU (located 19.4 NM [22.3 miles or 35.9 km] away) would be visible, as follows:

$$(1.17) (\text{square root of } X \text{ feet}) = 2.6 \text{ NM}$$

$$\text{Square root of } X \text{ feet} = 2.6 \div 1.17$$

$$X \text{ feet} = (2.6 \div 1.17)^2$$

$$X = (2.2)^2$$

$$X = 5 \text{ feet}$$

This means that someone standing on top of Malibu Bluffs should be able to see a point on the FSRU 5 feet above the water surface; in other words the top 159 feet of the FSRU ( $164 - 5 = 159$ ).

## 2.2 Project Related Views From Offshore

A viewer on a small boat can calculate the distance to an object if the eye height and the height of the object are known. Using the same formula, they would calculate the distance to their visual horizon and the distance from the object to the horizon and add the two together. Therefore, assuming the viewer's eyes are 5 feet (1.5 m) above sea level and the top of the object is 164 feet (50 m) above sea level, the distance to the object would be:

$(1.17) \times (\text{square root of eye height (in feet) above the water}) = \text{distance to the horizon in nautical miles (NM)}$
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$$\begin{aligned}
 &((1.17) (\text{square root of } 5)) + ((1.17) (\text{square root of } 164)) = \\
 &((1.17) (2.236)) + ((1.17) (12.806)) = \\
 &(2.616) + (14.983) = \\
 &17.6 \text{ NM}
 \end{aligned}$$

This means that the person in the boat would begin to see the FSRU from approximately 17.6 NM away. Using these same formulas, if the viewer's eye height and distance to the FSRU are known, how much of the FSRU would be visible at any given point can be determined. For example, if the small boat was 11.8 NM from the FSRU, then:

$$\begin{aligned}
 &((1.17) (\text{square root of } 5)) + ((1.17) (\text{square root of } X)) = 11.8 \\
 &(2.616) + ((1.17) (\text{square root of } X)) = 11.8 \\
 &(1.17) (\text{square root of } X) = 11.8 - 2.616 \\
 &(1.17) (\text{square root of } X) = 9.184 \\
 &\text{Square root of } X = 9.184 \div 1.17 \\
 &\text{Square root of } X = 7.85 \\
 &X = 7.852 \\
 &X = 62 \text{ feet}
 \end{aligned}$$

Therefore, the viewer would be able to see above a point on the FSRU 62 feet (19 m) above sea level or, in this case, from the main deck to the tops of the Moss tanks.

## 3. Summary

At both onshore locations the FSRU would appear as a small, featureless object on the horizon, and often would not even be visible due to typical hazy atmospheric conditions in the area. Also, because of the distance, details of the FSRU would not be discernible. When visible, viewers would most likely assume

that it is a vessel in the shipping lanes because of its location in a marine environment.

Simulations of the FSRU from higher elevations at distances similar to those from Leo Carrillo State Beach and the Malibu Bluffs would not result in substantially different views because what the human eye can see from these distances, regardless of elevation, would not be detectable.